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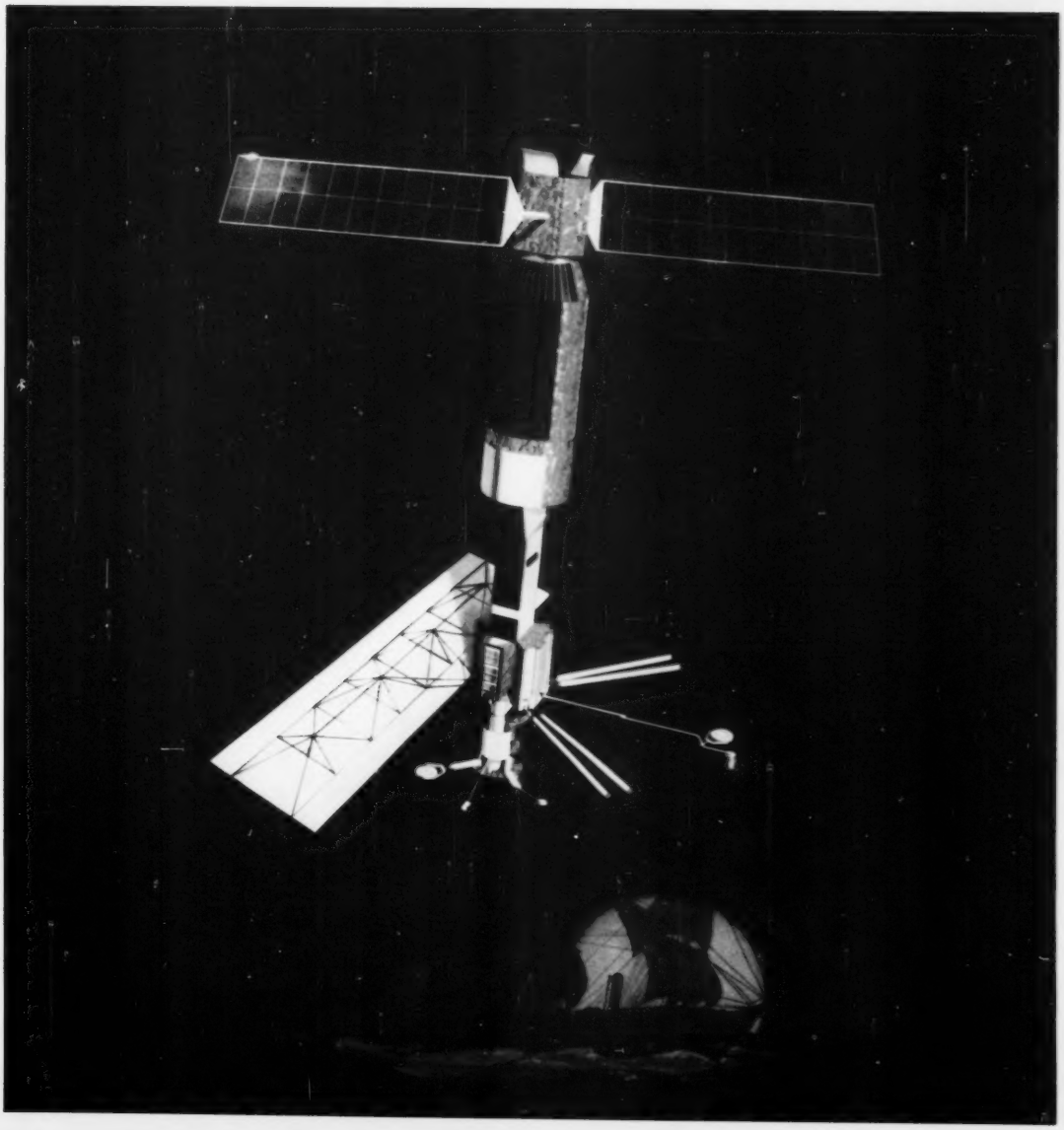

About the Cover

Artist concept of Seasat (for Specialized Experimental Applications Satellite), the first spacecraft devoted to oceanographic studies, launched June 26, 1978. Seasat is superimposed over an image of the ocean vessel, HMS Challenger, whose round-the-world voyage over 100 years ago became the model for oceanographic voyages.

Seasat's microwave sensor data began a new era of resources surveying—reporting on such variables as sea temperature, wave height, surface wind speeds and directions, sea ice and storms. Seasat was to survey 95 percent of the world's oceans every 36 hours.

Information from Seasat was distributed to a large user community for predicting weather, routing shipping and issuing disaster warnings.

After three months in orbit, an electrical power failure occurred on board the spacecraft which ended the mission. However, enough data had been recorded to verify the effectiveness of the instrumentation and the existence of a group of potential users in the weather, maritime and fisheries communities.

Correction: In the March 1983 edition, p. 2, paragraph 3 of "About the Cover," line 10 should read: 107,960 meters (354,200 ft., or more than 67 miles) . . . .

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Shuttle Mission 7 — Pre-launch Statistics

Crew ..... Robert L. Crippen, commander
Frederick H. Hauck, pilot
John M. Fabian, mission specialist
Sally K. Ride, mission specialist
Norman E. Thagard (M.D.), mission specialist

Orbiter ..... Challenger (OV-099)

Launch site ..... Pad 39A
Kennedy Space Center, Fla.

Launch date/time .. * June 18, 1983
7:33 a.m. EDT

Main Engine
Cutoff (MECO) ... 8 minutes, 19.7 seconds, Mission Elapsed Time (MET) (nominal)

OMS 1 Burn ..... 10 min., 13.7 sec., MET (nominal)
resultant orbit: 160 × 52 nautical miles

OMS 2 Burn ..... 44 min., 23.7 sec., MET (nominal)
resultant orbit: 160 × 160 nautical miles

Orbital
inclination ..... 28.5 degrees

Mission duration ... 6 flight days/ 143 hours
95 full orbits; deorbit burn on 96th orbit

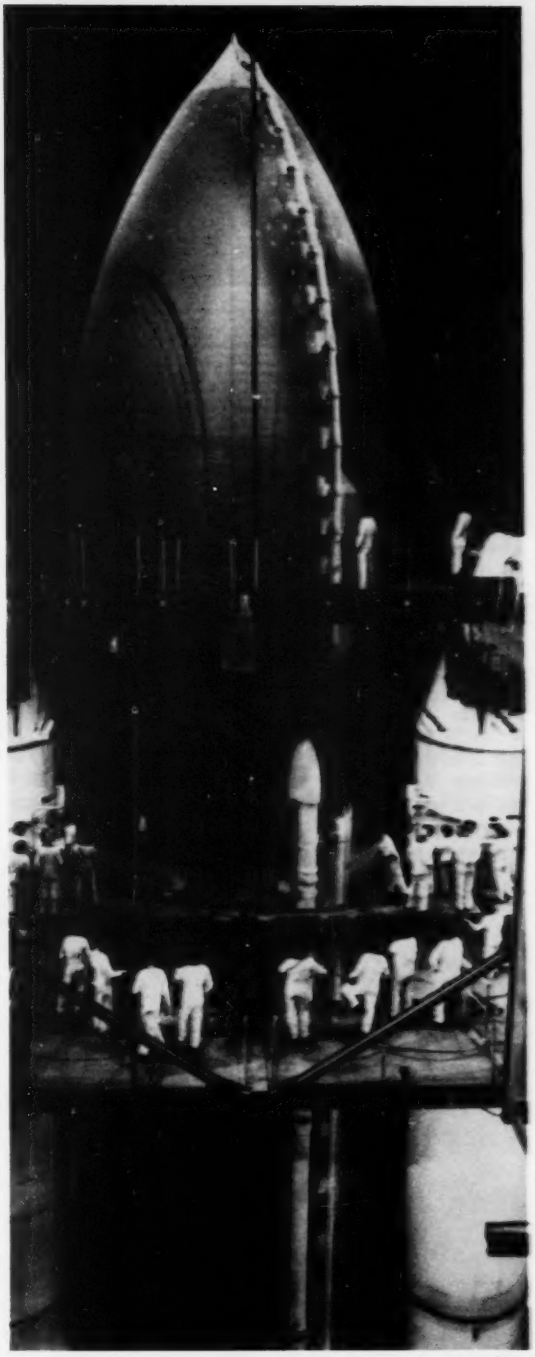
Deorbit burn ..... 5 days, 22 hrs., 23 min., 25 sec., MET (nominal)

Reentry
interface ..... 5 days, 22 hrs., 50 min., 11.5 sec., MET (nominal)

Landing date/time .. * June 24
6:53 a.m. EDT
5 days, 23 hrs., 20 min., 4 sec. MET

Mission firsts ..... First flight of 5 person crew
First use of the Remote Manipulator System to deploy and retrieve a commercial payload
First landing at Kennedy Space Center
First U.S. woman in space

* Subject to change; Mission Elapsed Times are approximate



ET for 7—External tank for Space Shuttle mission 7 in high bay 3 of Kennedy Space Center's Vehicle Assembly Building, where it was mated with Space Shuttle twin solid rocket boosters in early March.

Principal cargo . . . . OSTA-2 (for Office of Space and Terrestrial Applications) — 2 part payload:
Materials Assembly Experiment (NASA)
Material Scientific Autonomous Experiment (West Germany)
Shuttle Pallet Satellite (SPAS)-1 (West Germany)
Telesat-F (Anik C-2) (Canada)
Palapa B-1 (Indonesia)

Get Away Special (GAS)
Experiments . . . . . Total of 7 GAS canisters to be flown, containing:

**Canister 1: 5 German Youth Fair Program Experiments, including crystal study; metals processing; plant contamination; plant seed studies; microprocessor controlled sequencer — sponsor, Kayser Threde of West Germany

Canister 2: Use of ultraviolet spectrometer to observe emissions from the environment of near space and upper atmosphere — sponsors, U.S. Air Force and U.S. Naval Research Laboratory

Canister 3: Three experiments by Purdue University students: geotropism of sunflower sprouts; fluid dynamics of an immiscible fluid mixture in microgravity; use of lexan plastic to investigate the hit frequency, energy, and velocity of nuclear particles in near-Earth environment — sponsor, Purdue University

Canister 4: Two experiments from Caltech students: Response of germinating radish seedlings to varied types of simulated gravity conditions ranging from $1/10{,}000$th to 132d of gravity on Earth; Study of coalescence and free convection in Space Shuttle environment — sponsored by Stephen Spielberg, Culver City, Calif.

Canister 5: Investigation of the effects of launch and on-orbit environment on a colony of ants, prepared by Camden New Jersey high school students — sponsor, RCA, Camden, N.J.

Canister 6: Measurement of the effects of Shuttle bay environment on Eastman Kodak type 101 ultraviolet sensitive film — sponsors, NASA Goddard Space Flight Center and U.S. Naval Research Laboratory

Canister 7: Investigation of the basic physics of soldering in microgravity and in a vacuum — sponsor, Edsyn, Inc., Van Nuys, Calif.

Other experiments
Aerodynamic Coefficient Identification Package (ACIP)
Monodisperse Latex Reactor (MLR)
Sponsors: NASA Marshall Space Flight Center and Lehigh University, Bethlehem, Pa.
Continuous Flow Electrophoresis System (CFES)
Sponsors: NASA/McDonnell Douglas joint venture

Medical tests (conducted by Thagard) . . . . . Validation of predictive tests and counter measures for space motion sickness (pre-sleep)

Cardiovascular deconditioning counter-measurement assessment

Head and eye motion monitoring during ascent and entry

On-orbit head and eye tracking (conducted 1 day, 21 hrs., MET)

Near vision acuity (conducted day 1 MET; twice on day 5 MET)

Microbiological screening test (conducted day 1 and day 4)

** Use of canister number is for listing purposes only and does not imply the placement of the experiments on board Challenger

Principal mission activity . . . Deployment of Telesat-F (Anik C-2) satellite
9 hrs., 43 min., 41 sec., MET
orbit 7, descending node
separation from Challenger at Delta V of 10 fps at 165 × 160 n. mi. orbit

Deployment of Palapa B-1 satellite
1 day, 2 hrs., 8 min., 7 sec., MET
orbit 18 on descending node
separation from Challenger at Delta V of 10 fps at 170 × 160 n. mi. orbit

Deployment of SPAS using Remote Manipulator System; approximately 18 hrs. total of on-orbit activity, scheduled during:
Flight Day 4 — orbits 35-37; 47-48
Flight Day 5 — orbits 49-52; 61-64
Flight Day 6 — orbits 65-67

TDRS navigation tests

S-band communications tests

Preferred Landing Site . . . . . Shuttle Landing Facility
Kennedy Space Center, Fla.
orbit 96

Backup Landing Site . . . . . Shuttle Landing Facility
Kennedy Space Center, Fla.
orbit 97

Shuttle Mission 7 Crew—Center, counter clockwise: Robert L. Crippen, commander; Sally K. Ride, mission specialist; John M. Fabian, mission specialist; Norman E. Thagard, mission specialist; and Frederick H. Hauck, pilot.

Weather alternate
landing site ..... Edwards Air Force Base, Calif.
98th orbit

Contingency
landing sites ..... White Sands Missile Range, N.M.
Rota Naval Station, Spain
Hickam Air Force Base, Hawaii
Kadena Air Base, Okinawa

Abort
landing sites ..... Return-to-Launch-Site: Kennedy Space Center, Fla.
Abort-Once-Around: Kennedy Space Center, Fla.
Transatlantic: Dakar, Senegal

America's First Woman in Space

Name ..... Sally Kristen Ride (Ph.D)
NASA mission specialist

Age 31

Flight
assignment .. Space Shuttle Mission 7
June 18-24, 1983

Education ... B.S., 1973, Physics, Stanford Univ.
B.A., 1973, English, Stanford Univ.
M.S., 1975, Physics, Stanford Univ.
Ph.D, 1978, Physics, Stanford Univ.

NASA
experience .. Selected as astronaut candidate in Jan. 1978, Group 8
Aug. 1979 completed one year of training and evaluation; qualified for flight status as NASA astronaut (1 of 8 women astronauts in total astronaut corps of 78)
Specialized training in Remote Manipulator System operations
On-orbit Capsule Communicator (CAPCOM) for Space Shuttle Mission 2 (Nov. 1981) and 3 (Mar. 1982)
Selected for Space Shuttle Mission 7, April 1982

Shuttle
mission 7
duties ..... Launch and ascent:
Mission specialist flight engineer; assists commander and pilot with flight procedures and monitors on-board systems
On-orbit:
Assists in deployment of Telesat-F (Anik C-2) satellite on flight day 1
Assists in deployment of Palapa B-1 satellite on flight day 2
Assists in Remote Manipulator System grappling, deployment, retrieval and berthing operations involving Shuttle Pallet Satellite; approximately 18 hrs. total of this activity
Assists in Continuous Flow Electrophoresis System and Monodisperse Latex Reactor experiment procedures
Primary responsibility for OSTA-2 experiments (activation and data monitoring)

Pioneer 10 Leaves the Solar System

On June 13, 1983, NASA's Pioneer 10 unmanned spacecraft will become the first to travel beyond the limits of the solar system as we now know it. With its crossing of the orbit of the planet Neptune on that date, Pioneer 10 will become the first human artifact ever to leave the solar system and the first flight by a spacecraft beyond the planets, reaching a distance farther from the Sun than any known planet.

Though Pluto is normally the outermost planet, its orbit is so elliptical that for the next 17 years it will be inside Neptune's orbit and Pluto will never again catch up with Pioneer.

Other definitions of solar system limits exist: the proposed comet belt (Oort cloud) at about 50,000 astronomical units (4.650 trillion miles from the Sun); or the fluctuating boundary between the Sun's atmosphere (the heliosphere) and the interstellar gas, at perhaps 5 to 10 billion miles out. However, the most obvious and popular of these limits is the point outside all the known planets, 2.8 billion miles from the Sun.

On April 25, 1983, Pioneer 10 was farther out than the planet Pluto by 2 p.m. PDT, having reached a distance 4,472,497,438 km (2,779,209,908 miles) from the Sun and traveling at 30,558 mph with respect to the Sun. By 5 a.m. PDT, on June 13, 1983, the spacecraft will have crossed the orbit of Neptune, at a point 4,527,978,612 km (2,813,685,909 mi.) from the Sun and will be then beyond all the known planets of the solar system.

Since its launch March 3, 1972, Pioneer 10, the first spacecraft to Jupiter, has traversed the asteroid belt, survived Jupiter's punishing radiation belts, and operated almost without flaw. By June 13, 1983, Pioneer 10 will have traveled 3.59 billion miles on its flight path, received more than 98,900 commands from Earth, and transmitted more than 126 billion bits of scientific data.

At Pioneer's Neptune distance of 2.81 billion miles, it will take 4 hours, 20 minutes for spacecraft data, traveling at the speed of light, to reach the Pioneer Operations Center at NASA's Ames Research Center, Mountain View, Calif.—a round trip communication time of 8 hours, 40 minutes. At Pluto distance, one way light time will be 4 hours, 16 minutes. At Neptune distance, communication time increases at an average of about one minute every four days.

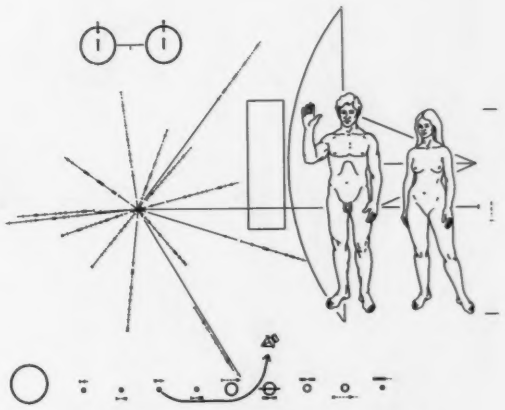
Over the next 850,000 years, Pioneer's closest approach to any star system probably will be to the star, Ross 248. This will take place 32,610 years from now, with passage at 3.27 light years from the star. Star trajectories are now well known and beyond 850,000 light years, closer approaches may occur. At typical star-separation distance, Pioneer 10 might expect a relatively close approach to a star system on an average of once every million years.

Pioneer 10 carries with it a message to any intelligent life who might encounter the spacecraft on its interstellar wanderings. This message is part map and part drawing engraved on a gold-anodized aluminum plaque. The map shows the location of the solar system and Earth referenced to easily identified objects (pulsars) in the galaxy and some basic scientific points to be used in interpreting the diagram. The plaque also features the drawing of a man and a woman with the man's hand raised in a gesture of greeting.

Pioneer 10 was designed to last the 21 months it took the spacecraft to rendezvous with Jupiter, its primary mission. But even after more than a decade in space, scientists are able to operate the spacecraft almost without flaw and receive valuable scientific information.

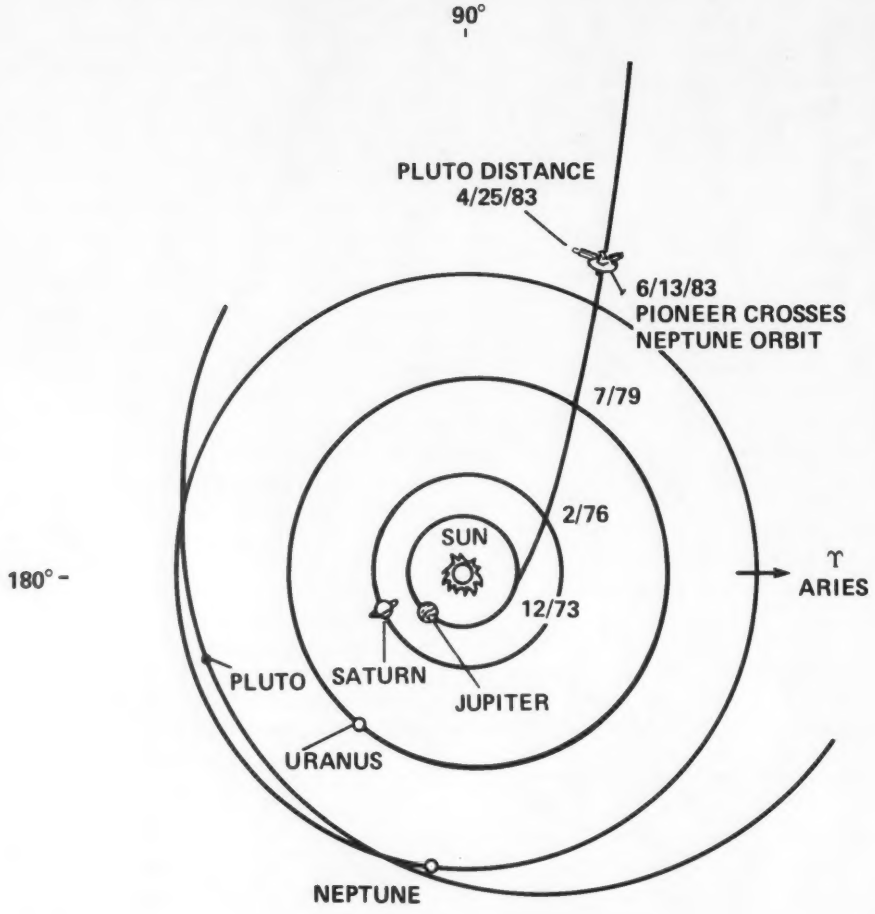
The spacecraft sends its information with an eight-watt radio transmitter, a power equivalent to a Christmas tree light. It uses a parabolic radio dish to focus the radio signal into a narrow, degree-and-a half wide, conical beam. Despite such a "tight" beam, by the time the signal reaches Earth it has spread over an area more than 11 million miles across.

When it is received by the 64-meter (210-foot)-diameter radio antennas of the Deep Space



Pioneer 10 plaque, part map and part drawing, intended to communicate with any intelligent life that might encounter the spacecraft during its interstellar journey. The map shows the location of the solar system with Earth referenced to identifiable pulsars within the galaxy; the drawings illustrate Earth's human inhabitants, a man and a woman, with the man's hand raised in a gesture of greeting.

PIONEER 10 BEYOND KNOWN PLANETS



Network (DSN), the original eight-watt signal has weakened to 20,000 trillionths of a watt (.000,000,000,000,000,005 watt).

According to Pioneer Project Manager Richard Fimmel, if the signal from the spacecraft could be collected and stored with one of the DSN radio dishes for 67 million years, the total energy collected would not be enough to power an eight-watt light bulb for even one-thousandth of a second.

That such a tiny signal is detectable at all is a tribute to the tremendous increases in antenna sensitivity that have occurred since the spacecraft's launch.

NASA hopes to track Pioneer 10 with the DSN radio receivers for another eight years, out to a distance of 5 billion miles. Tracking the spacecraft out to such a distance will provide scientists the information to build a much better picture of the "heliosphere."

The heliosphere is the diffuse extension of the Sun's

outer atmosphere that surrounds the entire solar system—a huge magnetic "bubble" created by the million-mile-an-hour solar wind.

Pioneer 10 has discovered that the heliosphere extends much farther than previously thought. Previously, the heliosphere's boundary, or "heliopause," was believed to lie just beyond Jupiter. But Pioneer 10 is now six times farther out and has yet to encounter any boundary.

Pioneer 10 has found that the heliosphere changes in response to magnetic storms on the Sun. It alters its bubble-shape as if it were a huge, pulsating jellyfish. The heliosphere also responds to the normal cyclic activity of the Sun. "We now believe the heliosphere-bubble 'breathes' in and out once every 11-year solar cycle," says Dr. John Simpson, University of Chicago, Pioneer experimenter.

Other Pioneer 10 accomplishments include:

- The discovery that Jupiter is a liquid planet;
- The first model for Jupiter's huge, pulsating magnetosphere and tremendously powerful radiation belts;
- The first accurate measurements of the masses and densities of Jupiter's planet-sized moons;
- The first close-up pictures of Jupiter's Great Red Spot and the circulation belts and zones of the giant planet's swirling atmosphere; and
- Proof that interplanetary dust causes gegenschein and the Zodiacal light.

Pioneer 10 is managed by NASA's Ames Research Center, Mountain View, Calif. The Pioneer 10 and 11 spacecraft were built for NASA by TRW, Inc., Redondo Beach, Calif.

Planetary Exploration Through Year 2,000 Outlined

NASA's Solar System Exploration Committee has presented its recommendations to the agency Administrator and to NASA's Advisory Council for a core program of planetary exploration to be flown through the year 2,000.

The Solar System Exploration Committee was established in 1980 as an *ad hoc* committee of the NASA Advisory Council to re-examine planetary exploration. The resultant two-year joint effort study by NASA and members of the scientific community reviewed the goals of solar system exploration, identified the essential attributes of a viable program in planetary sciences, and defined new ways to reduce costs.

Based on findings of the study, the Committee has formulated a long-term core program for planetary sciences designed to maintain high-quality science within a framework of cost-saving innovations in both engineering and management. The Committee's recommendations for the program include using derivatives of commercial, Earth-orbital spacecraft for inner planet missions (Planetary Observers) and a new, modular spacecraft named the Mariner Mark II, which can be reconfigured for a variety of missions to the outer planets, comets, and asteroids.

The first four proposed missions are:

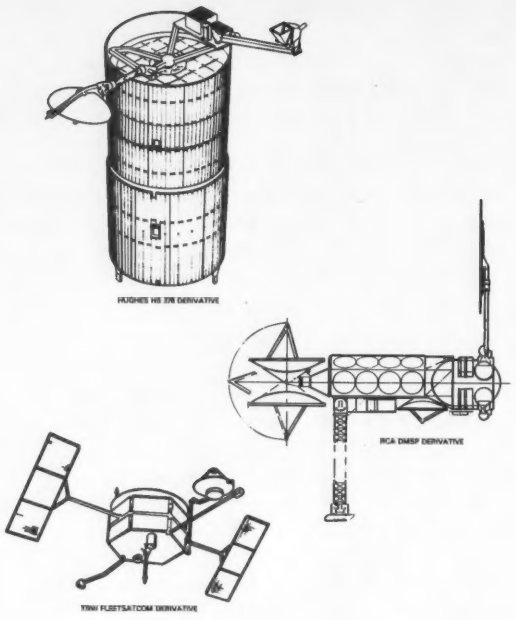
Venus Radar Mapper—To be launched in 1988, this mission will provide a radar map of the cloud-enveloped surface, with a resolution of approximately one kilometer, equivalent to that carried out by television cameras aboard the first Mars orbiter, Mariner 9. The spacecraft, which has been derived from the more complicated and expensive Venus Orbiting Imaging Radar Mission (VOIR), also will carry a radar altimeter to provide topographic information, and a gravity sensor. Venus Radar Mapper has been presented to the Congress as a new start in FY 1984.

Mars Geoscience/Climatology Orbiter—This mission, recommended for launch in 1990, would be the first to use the new Planetary Observer spacecraft. Its purpose is to orbit Mars for one Martian year (approximately two Earth years) with a variety of sensors, gathering information on the planet's surface composition, magnetic field (if any), and seasonal cycles of carbon dioxide, water and dust that interact between the surface and atmosphere.

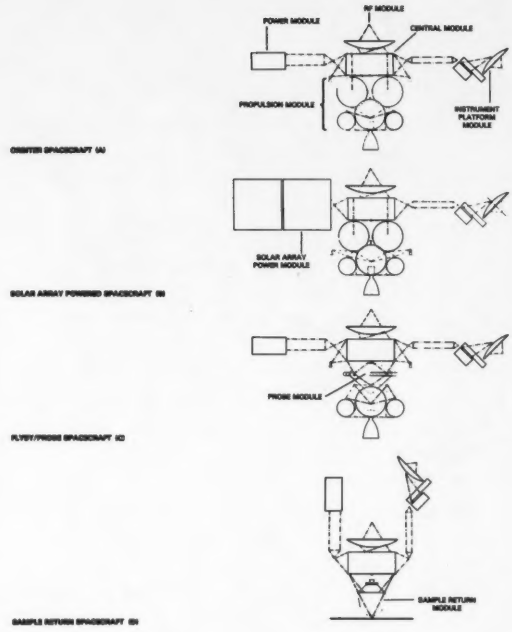
Comet Rendezvous/Asteroid Flyby—The new spacecraft, Mariner Mark II, is recommended to rendezvous with a short period comet as it approaches the Sun then recedes into deep space. The spacecraft would carry cameras and remote sensing instruments to study the gas and dust boiling off the comet's nucleus, plus sensors to directly measure the gas and dust composition.

Three suitable targets have been identified—comets, Enke, Tempel 2 and Honda-Mrkos-Pajdusakova (HMP)—which could be encountered in the mid-1990s after first flying by a Mainbelt asteroid.

Titan Probe/Radar Mapper—Proposed for launch somewhere between 1988 and 1992, this mission would examine the unique, orange-colored atmosphere that shrouds Saturn's largest moon and its mysterious surface—which is cold enough for methane to form pools or possibly oceans. It would parachute a package of instruments through the atmosphere and use the probe carrier to send back radar images of the surface. The



Planetary Observer Spacecraft—Proposed by the Solar System Exploration Committee, this low-cost moderately scaled spacecraft, to be used for inner solar system missions, would make use of already developed Earth orbital spacecraft. Shown here are derivatives of three types that serve as examples of this concept. Clockwise from top: Hughes Aircraft Co. HS 376 communications satellite; RCA's DMSP meteorological satellite; and TRW's FLTSATCOM communications satellite.



Mariner Mark II—Spacecraft design proposed by the Solar System Exploration Committee for missions to comets, asteroids and outer planets. The Mariner Mark II would be a new simple spacecraft designed for deep space missions and reconfigurable to accommodate a number of missions. Top frame shows a nuclear-powered version that could be used at Saturn; second frame from top, a solar powered version of the same spacecraft to be used for a comet rendezvous; third frame from top, a flyby/probe configuration for a comet rendezvous; and bottom frame, a configuration for a comet atomized sample return mission.

mission, if upgraded, would also employ a full-scale Saturn orbiter to study the planet's atmosphere, magnetosphere, satellites and rings. The combined probe/orbiter is considered an excellent candidate for international cooperation.

Other missions such as the return of samples from Mars and comets, rovers exploring the Martian surface, and a buoyant station floating in Titan's atmosphere are excluded from the core program because of their high cost and technological complexity. Such advanced missions, which might be mounted in an expanded budgetary climate, currently are under study. The committee's recommendations for this augmented program are scheduled to be released at the end of this year.

Current chairman of the committee is Dr. David Morrison, professor of astronomy at the University of Hawaii; its immediate past chairman is Dr. Noel W. Hinners, director of Goddard Space Flight Center, Greenbelt, Md. Dr. Geoffrey Briggs, the new director of the Solar System Exploration Division, NASA Headquarters, is executive director of the committee.

Crustal Dynamics—The Earthquake Connection

Is there a connection between earthquakes and the variations in Earth's polar motion and rotational rate? Is this the earthquake connection? Scientists in the Crustal Dynamics Project of NASA's Geodynamics Program are looking for answers to this question in the hope that knowledge gained from their research may make possible the prediction of major earthquakes that will allow for the advance planning and precautions to save lives and property.

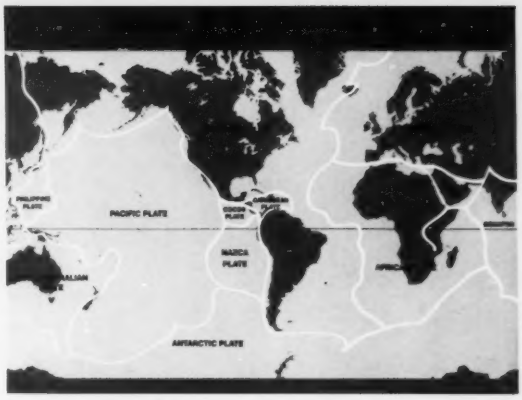
Managed at NASA's Goddard Space Flight Center, Greenbelt, Md., and supported by NASA's Jet Propulsion Laboratory, Pasadena, Calif., the project is concerned with obtaining highly accurate observations and measurements of the rate of Earth's polar rotation, changes in pole position, and the changes in shifts in the Earth's crust—or crustal dynamics. These studies by NASA are an important part of an interagency Federal Program for the Application of Space Technology to Crustal Dynamics and Earthquake Research.

Earthquakes are among the natural enemies that can be catastrophic to human life and property; and the fact that they are unpredictable makes it difficult to take protective action against them. However, it appears now that measurement techniques, using space technology, may bring us closer to earthquake prediction—at least of major earthquakes.

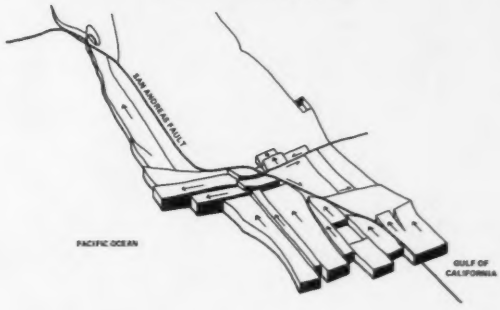
A major area of study by NASA within the Crustal Dynamics Project is the region of the San Andreas Fault, part of the boundary between the Pacific Plate and the North American Plate. Two of the great earthquakes in history have taken place on the San Andreas—near San Francisco in 1906, and at Fort Tejon in southern California in 1857. Geological studies show that great earthquakes occur approximately every 150 years on the San Andreas, and the U.S. Geological Survey has estimated a 50 percent probability that southern California will experience a great earthquake within the next 20 years—with catastrophic loss of life and property in the Los Angeles area. It is not a question of whether such a disaster will happen, but when.

The U.S. Geological Survey is the lead agency in a research program to develop a practical earthquake prediction and hazard alleviation program. Scientists believe that an important aspect of achieving such a system is understanding how strain builds up in the Earth's crust—to be eventually released in the form of earthquakes.

Geological studies show that the average motion between the Pacific and North American Plates is about 5.5 centimeters per year, but the rate of movement in California is highly variable both in space and in time. There has been no fault motion near San Francisco since 1906 and in southern California since 1857; the faults of the Imperial Valley show movement at about the expected rate of 5 centimeters per year; in central California, the San Andreas is creeping at a rate of 3.3 centimeters per year, but every few decades there are major earthquakes on small faults which branch off the San Andreas. The Coalinga earthquake of May 2 is an example of a destructive earthquake on a previously unknown fault.



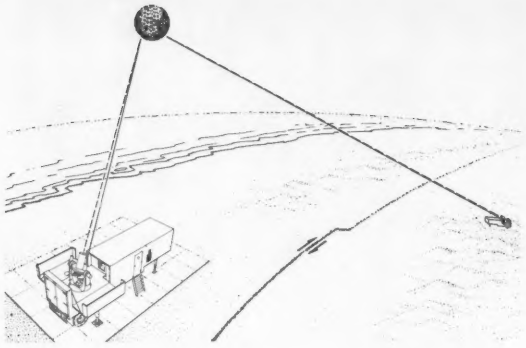
THE SAN ANDREAS FAULT SYSTEM



A major problem in geophysics today is to explain the variation in movement from place to place on the San Andreas, and particularly NASA observations since 1972 from the Northern Sierra Nevada to San Diego which show a movement of 8 centimeters per year—significantly larger than the geological prediction or any of the ground measurements close to the fault.

Space technology contributes to earthquake prediction by providing accurate measurements of crustal movements over distances where conventional measurements either are not accurate enough or would be too expensive.

Two types of space systems currently used are laser ranging systems and microwave interferometry systems. With respect to laser ranging, an Earth-orbiting satellite, as it passes over the San Andreas fault (or other potential earthquake areas under observation), is tracked by laser systems placed at different points on either side of the fault. The laser beams are bounced off the satellite to determine the location of the laser system and the distance between lasers to a few centimeters.



Satellite laser ranging methods use the NASA Laser Geodynamics Satellite (Lageos). A pulse of light is sent from ground stations to Lageos, and the time taken for the pulse to reflect off the satellite and return to the laser station is measured. Since the Lageos orbit is known precisely, the position of the stations can be accurately determined.

A description of how this technique is performed is described in the 1982 report of the *Federal Implementation Plan for the Application of Space Technology to Crustal Dynamics and Earthquake Research:* "Laser ranging systems measure the round trip time of flight of very short laser pulses to a reflector on a natural or artificial satellite. This allows computation of the distance from the laser to the target. Through multiple measurements . . . geodetic positions in an Earth-centered system, and polar motion and Earth rotation, can be derived.

There are two kinds of laser ranging: satellite laser ranging with a reflector on an artificial satellite, and lunar laser ranging, where a reflector is located on the Moon. Satellite laser analyses are accomplished by means of Lageos, a spherical satellite covered with retroreflectors, launched in 1976 to a high altitude to facilitate more accurate determination of orbit.

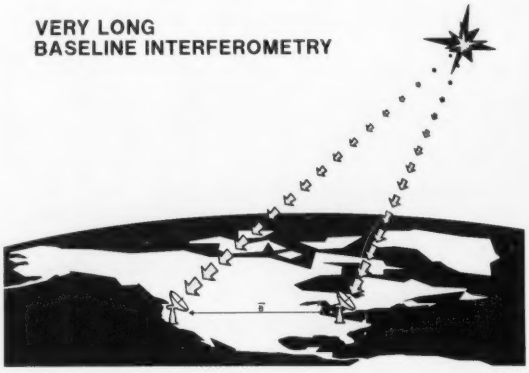
Laser ranging by NASA is done by beaming lasers into space from fixed and from mobile stations. The latter have vastly accelerated the accumulation of important data by means of laser equipment on vans and trucks. In 1980, NASA was the only organization with such equipment. We also operate several fixed stations.

NASA is cooperating and participating in its laser ranging program internationally with over 20 countries, among them Japan, Germany, and The Netherlands. Each nation has its own special region for earthquake research. NASA's region for study is located in California, largely the San Andreas fault zone. But observations will be made all over the world in the effort.

In addition, the NASA Crustal Dynamics Project is contributing to an understanding of the evolution of the Earth, including the way that mineral and petroleum deposits are generated. Opportunities are offered by our nation to less developed countries to participate in this research at low cost with little investment. NASA helps train observers from other countries in our hemisphere and elsewhere so that each may work on subjects of special national interest—a venture that illustrates an opportunity well taken to use science as a tool of positive diplomacy.

Microwave interferometry systems determine the difference in time of arrival of signals from astronomical radio sources at pairs of stations. If the two stations are connected and use the same master clock for timing, it is called Connected Element Interferometry or CEI. If the two stations are unconnected and use different clocks of choice, very far apart, it is designated Very Long Baseline Interferometry—VLBI. VLBI is used largely in NASA's crustal dynamics work.

Satellite tracking and other measurements and observations made along the San Andreas fault are expected to reveal the pattern of movement of the immense layers or plates of the Earth along these boundaries and, further, to enable scientists to identify areas that should be instrumented to predict earthquakes with precision. It is estimated that highly accurate predictive capabilities will allow enough advance warning time for useful action to be taken before the earthquake occurs.



Very Long Baseline Interferometry works by recording noise from extragalactic radio sources (quasars) at two or more radio observatories. This interferometric technique is used by radio astronomers to study the quasars, but highly accurate measurement of the baseline between the radio antennas can be made using modern geodetic-quality modifications of the antennas.

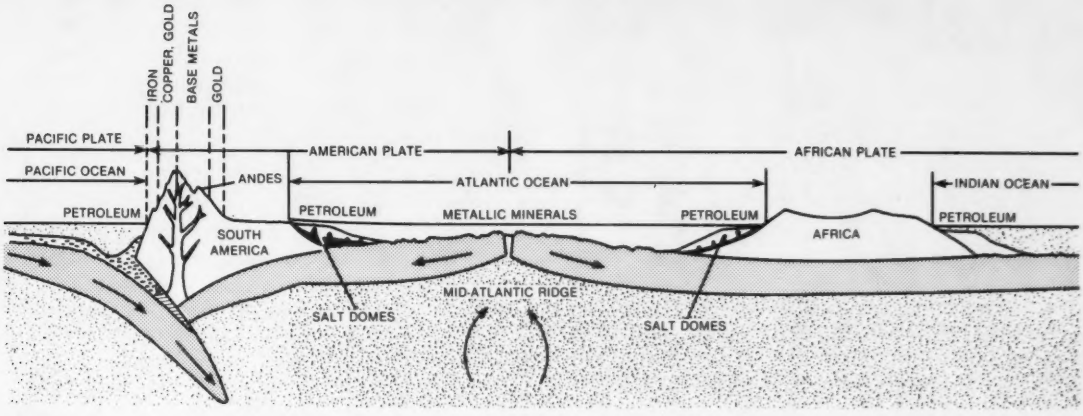


Plate Tectonics and Mineral Resources—The Earth's crust is now known to be broken into about a dozen "tectonic plates" which move almost rigidly with respect to one another, spreading apart at the mid-ocean ridges and plunging down into the mantle at trenches such as the west coast of South America. Mineral and petroleum resources are closely associated with these tectonic features.

Much is being done to obtain the knowledge to subdue earthquakes, one of mankind's natural enemies; but though the goal is nearer, it is not yet within our grasp. Directing efforts toward this achievement are Thomas Fischetti, Geodynamics Branch Chief, NASA Headquarters; Robert J. Coates, Crustal Dynamics Project manager, Goddard Space Flight Center; and Edward A. Flinn, Chief Scientist of the Geodynamics Branch, NASA Headquarters.

New Evidence Revealed on Meteorite Origin

A rock specimen collected from the Antarctic ice cap in Jan. 1982 has been identified as a meteorite of lunar origin. In addition, new scientific evidence supports that a class of nine meteorites, classified as the SNC group, could have been formed on Mars.

Lunar Origin Meteorite

The specimen was collected in the Antarctic in Jan. 1982 by a joint expedition sponsored by NASA, the Smithsonian Institution, and the National Science Foundation. The sample, named ALHA 81005 (ALHA stands for the Allan Hills region where the specimen was found), was one of about 375 new meteorites picked up that year from the polar ice cap and one of more than 6,000 meteorites found in the Antarctic since active collecting began in 1975.

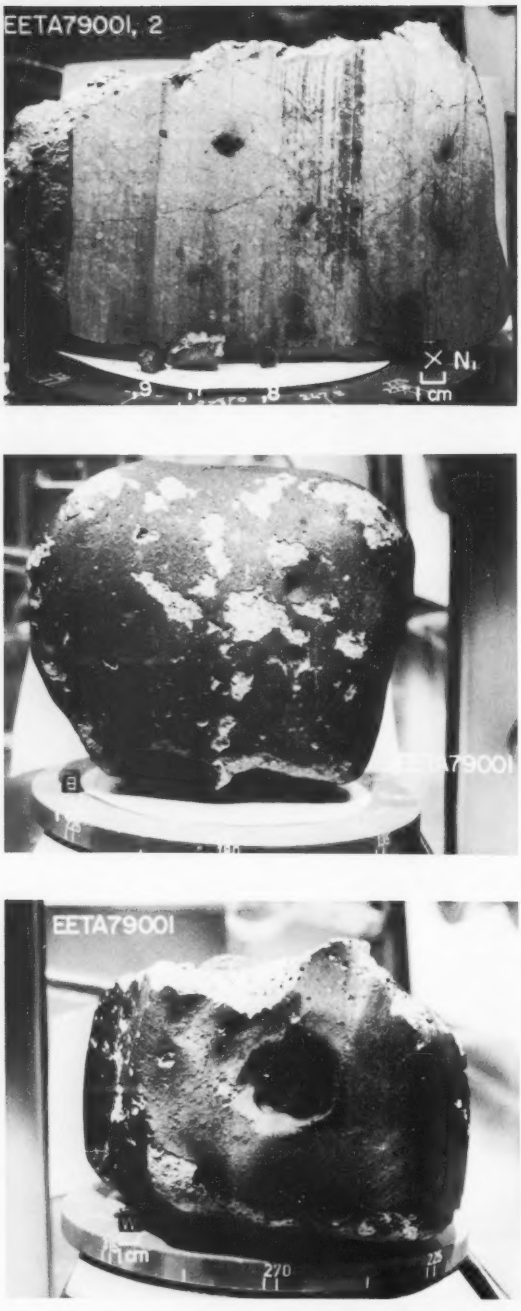
"It's definitely a meteorite," says Dr. William Cassidy of the University of Pittsburgh, who led the expedition. "It has a fusion crust around it where the outside melted coming through the atmosphere. There is no question that it came from outer space." The uniqueness of ALHA 81005 was recognized from the beginning. John Schutt, the glacial geologist who spotted it, noted the unusual greenish-brown color and frothiness of the glass layer. Beneath the glass, the sample was made up of small fragments of white rock cemented by more glass into a texture unlike that of most meteorites.

"What it looked most like was some of the Apollo 16 breccia samples from the lunar highlands," said Dr. Brian Mason of the Smithsonian Institution's National Museum of Natural History, who made the first microscopic examinations of ALHA 81005 when the sample arrived in the United States last fall.

Dr. Mason's eyeball analysis has been confirmed in detail with extensive analytical results obtained on about a gram (1/28 ounce) of material. After detailed measurements of the mineral composition, chemistry, gas content, radioactivity and other properties, scientists seem unanimous that ALHA 81005 came from the Moon.

No matter what test has been applied, ALHA 81005 looks like the lunar samples returned by the manned Apollo missions and not like terrestrial rocks or meteorites. For example, the ratios of the elements iron and manganese in pyroxene, one of the minerals found in ALHA 81005, are identical to values measured on lunar samples and very unlike values measured on meteorites.

Studies of ALHA 81005's chemistry also point to a lunar origin. "I'm positive it's lunar," said Dr. J.C.



Three different views of meteorite sample designated EETA79001 under study in Johnson Space Center's Planetary and Earth Sciences Laboratory. The sample was discovered nearly two years ago by an Antarctic recovery team and is thought to be of possible Martian origin.

Laul of Battelle-Northwest, after only a few days of analytical work. The amounts of about 10 elements in ALHA 81005, including aluminum and the rare-Earth metals, are virtually identical to a sample of the lunar highlands (number 15418) returned to Earth by the Apollo 15 mission in 1971.

Studies of the element oxygen in ALHA 81005 provide yet another critical clue to its origin. Meteorites, terrestrial rocks and lunar samples all contain two types of oxygen atoms, one lighter than the other, and the ratio of the two kinds of atoms is different in specimens that come from different planets. Careful measurements of the oxygen in ALHA 81005 show that it is like lunar and terrestrial samples and not like known meteorites. "Since there is good evidence that it didn't come from Earth," says Professor Robert Clayton of the University of Chicago, describing his analyses, "I'm quite happy to accept a lunar origin."

Not only does it appear that ALHA 81005 came from the Moon, it probably sat on the lunar surface for as long as 100 million years before it was blasted to Earth. Rocks exposed at the airless surface of the Moon trap gases emitted from the Sun, and analyses of these gases in ALHA 81005 by Bogard, suggest a long residence on the lunar surface. "The amounts of the gases are very much like what we find in other lunar surface samples, especially the amount of excess argon, but much more than the amount of similar gases found in meteorites," Bogard said.

Bogard's gas analyses are being combined with measurements by Dr. J.C. Evans and his colleagues at Battelle-Northwest, who are studying the weak radioactivity produced in ALHA 81005 by cosmic rays before the rock reached the Earth. The two sets of measurements are being used to construct a history of ALHA 81005's wanderings. "It seems to have been exposed at the surface of the moon for as much as 100 million years," says Bogard, "which is the kind of result we get for other lunar samples. But the radioactivity data suggest that the sample was buried again for some time before it was ejected and sent to Earth."

Meteorites of Possible Mars Origin

In other studies conducted at NASA's Johnson Space Center in Houston, new evidence has been discovered to support that at least one and possibly nine meteorites found on Earth originated from Mars. If this idea is correct—and scientists are quick to say that the only conclusive proof would be to collect samples from the surface of Mars itself—these meteorites could be the most important extraterrestrial rocks studied here since

the first return of lunar samples by the crew of Apollo 11 in 1969.

The scientific detective story which has some planetary scientists believing that rocks from Mars are now being studied here on Earth begins in 1815, when a meteorite that fell near Chassigny, France, was recovered for scientific study. More than a century later, scientists would discover that this meteorite is fundamentally different from nearly all of the thousands of meteorites found on Earth—it is nearly 3 billion years younger. Then in 1965, another of these unique meteorites was found in Shergotty, India.

Because they were slightly different in composition, both the Chassigny and Shergotty samples became the first members of two rare classes of meteorites, the chassignites and the shergottites. In 1911, a similar but equally unique meteorite fell near Nakhla, Egypt, killing a dog. It also became the first of a class of meteorites, the nakhlites.

The nine so-called SNC meteorites which make up these three classes—four shergottites, three nakhlites and two chassignites—have been found around the world in places like Antarctica, Brazil, Nigeria and Lafayette, Ind.

These meteorites, unique chiefly because of their age, only 1.3 billion years, are incredibly young in comparison to other meteorites, all of which date back to the formation of the solar system about 4.5 billion years ago. The SNC meteorites, being 3 billion years younger, appear to have come from a different source than other meteorites, which apparently have formed in the asteroid belt between Mars and Jupiter.

When these unusually low ages were discovered in the 1960s, the real debate as to the origin of the SNC meteorites began. They are all igneous rocks, which means they cooled and crystallized from molten lava. This evidence that the SNC meteorites formed by volcanic eruptions about 1.3 billion years ago only added to the mystery of where they came from, for there was no obvious planetary source for such young volcanic activity. By 1.3 billion years ago, the Moon's volcanic activity had long since ceased. None of the more distant asteroids seem large enough to have generated prolonged volcanism. (The asteroid Vesta has been suggested, rather diffidently, as a possible source.)

Mars, however, is a large enough world to have generated the internal heat for relatively young volcanic activity. Realizing they had in their possession meteorites of unsual origin, scientists began to consider an unusual source, the planet Mars.

"In the pre-Apollo days, there was a round of conjecture about what type of material might come from the Moon," said Dr. Donald Bogard of Johnson's Planetary and Earth Science Division (PESD), which manages all of the samples returned from the Moon during the Apollo program. "It was suggested that certain types of meteorites might be like lunar material. So conjecture on something coming from the Moon is not new. That of Martian origin, however, is more recent."

These speculations were given increasing force in the 1970's, when NASA's Mariner 9 and Viking orbiters returned pictures of numerous volcanic landforms on Mars, many of which were about 1 to 3 billion years old—about the age of the SNC meteorites.

In the past three years, studies of the shergottite group added important new evidence. All four of the samples—one from India, one from Nigeria and two from the Antarctic—were found to have been subjected to intense shock waves, like those generated by intense meteorite impacts about 180 million years ago. Moreover, all the shergottites were also exposed to cosmic-ray bombardment in space as small fragments about 2 million years ago. "An interpretation of those ages," said Dr. Lawrence Nyquist of Johnson, "is that these samples cooled from molten rock 1.3 billion years ago, were somehow ejected from a parent planet 180 million years ago as a large block more than 2 meters across, and that small fragments broke off in space about 2 million years ago. Those fragments later landed on Earth."

But how did they get here? More perplexing, how did they leave the parent body in the first place? The first serious suggestion that Mars was the source was considered improbable by theoreticians. How, they wanted to know, could a block of material escape the gravity field of Mars? A meteorite capable of imparting the necessary velocity (3.7 kilometers per second), they said, would more likely vaporize rather than eject surface rocks. How could such ejected rocks penetrate Mars' thin but resistant atmosphere? And even if such a collision could send chunks of rock flying off into space from Mars, then why have not samples from the much closer Moon been similarly propelled to Earth and found?

Nyquist and Bogard, among others, decided to try to decipher the puzzle. At the Lunar and Planetary Science Conference in Houston held in March, Nyquist presented a paper which is the latest answer to the problem of how the samples might have gotten to Earth from Mars. Drawing on past research, including his own, he suggests that a large meteorite striking Mars with a high enough velocity and a low angle of impact (about 15 degrees from the surface) could impact and

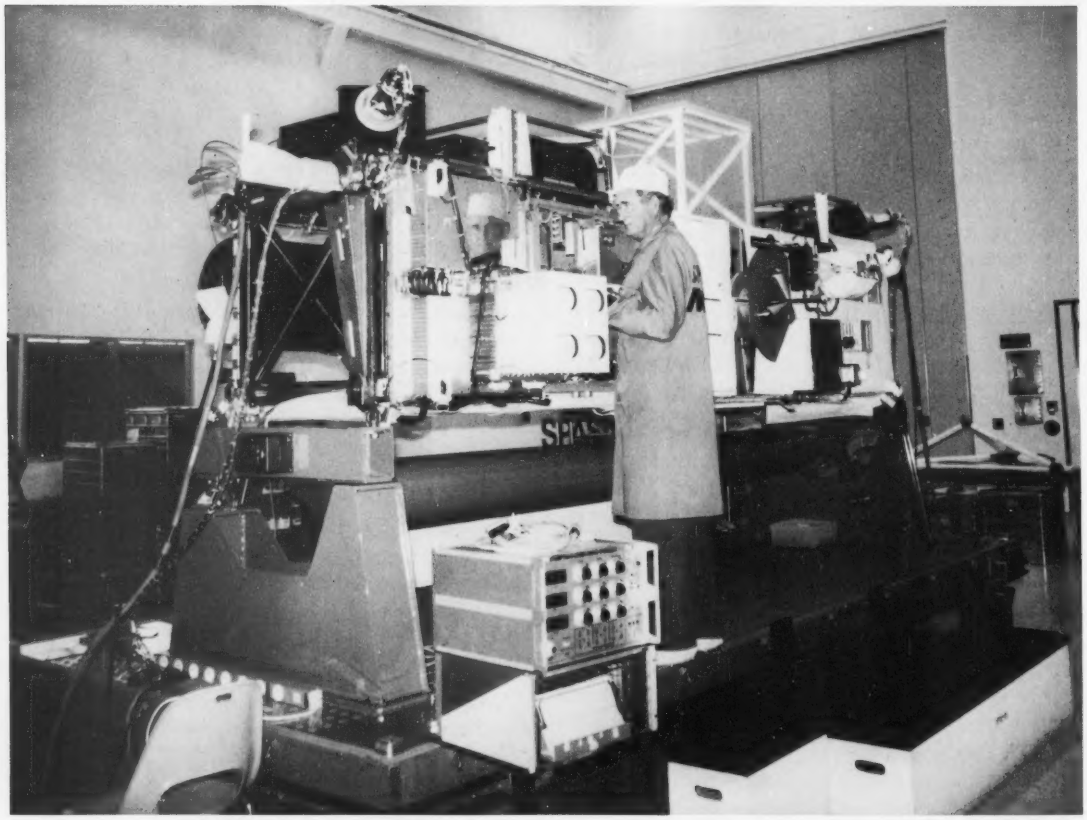
then ricochet at high velocity partly vaporizing itself in the process. The vapor cloud produced by the impact and vaporization would carry with it pieces of the Martian surface, accelerating them to the high escape velocity needed to leave the planet.

This mechanism could explain how rocks are blown into space from the surface of Mars, but then why haven't scientists discovered rocks on Earth similarly blasted off the nearby Moon? Such grazing meteorite impacts must also occur on the Moon, and the lunar crater Messier is generally considered as the classic example of the result of a grazing impact, with ejecta spread around it in a typical "butterfly" pattern.

The answer to this question may also have been found recently in Antarctica. A small meteorite, weighing only a little more than an ounce, was recovered last year from a desolate area called Elephant Moraine. At a first glance, this sample seemed identical to rocks returned from lunar highlands by Apollos 15, 16 and 17.

Although the scientists actively studying this sample are not yet convinced that it comes from the Moon, they should be able to settle the question by comparing its mineral composition, chemistry and age with definite lunar samples. If the rock does come from the Moon, it seems possible that similar impacts could have sent us rocks from Mars as well.

Nyquist believes the possible lunar sample found in Antarctica represents further circumstantial evidence for his theory, but, he adds, that even without this find, there is an explanation for the near-absence of lunar samples on Earth and the apparent relative abundance of



Satellite Checkout—Technicians perform pre-launch work on the SPAS-01 (Shuttle Pallet Satellite) of West Germany, in Hangar S. of Cape Canaveral Air Force Station, Fla. The pallet, to be launched aboard Challenger in June, consists of a narrow beam-type structure to be mounted in the orbiter's cargo bay with a complement of experiments attached to the beam. SPAS-01 will be deployed by the Remote Manipulator System (robotic arm) and contains power and attitude control systems that will allow it to serve as a free-flier for short durations.

Martian ones. The difference arises from the simple fact that it takes much longer for a meteorite to travel from Mars to Earth than from the Moon to Earth. An impact large enough to propel rocks into space occurs on either Mars or the Moon only about every 100 million years, he says, and the Mars-to-Earth travel time is more than 100 million years. This means that there is an essentially steady flow of small amounts of material coming from Mars. A rock blasted from the Moon, on the other hand, would be quickly swept up by the Earth's gravity, probably within a few days and the lifetimes of stony meteorites, exposed to terrestrial weather is at most only a few hundred years.

At the same time that Nyquist's research is entering the field, Bogard is wrapping up a paper which makes the evidence for Martian origin of the rocks even more persuasive. Another Antarctic meteorite, a shergottite collected in 1979, also from the Elephant Moraine region near the U.S. McMurdo Base, contained traces of the noble gases (argon, krypton, xenon, etc.) similar to those measured on Mars by the Viking landers. Measurements of these gases in the meteorite (sample EETA 79001) "don't look like anything so much as the Viking measurements of the Martian atmosphere," Bogard said.

Besides chemical abundance patterns in the meteorites that point to Mars, Bogard's experiments in the last few months have turned up isotopic patterns that are also close to what the Viking landers measured. Argon-40, for example (not the more common argon-38), is anomalously plentiful on Mars, and the similar argon-40 and helium-4 abundances found in the Antarctic meteorite lead to a strong suggestion of Martian origin.

"It is one more line of evidence," Bogard said. But on the side of caution, he added, "Our studies are like fingerprint comparisons. But in the case of Mars, we have a rather smudged print. There are certain types of information which can only be derived from actually handling a sample, such as mineral chemistry and mineral petrology. Viking measured a fine dust surface layer, not rocks, to get a chemical composition of the surface. However, there are several elemental abundance patterns and certain signature patterns which make for a reasonably strong argument of Martian origin."

So far, the caution inherent in scientific detective work prompts researchers here to suggest a Martian origin specifically for sample EETA 79001 only, a shergottite, for both geochemical and geologic reasons. But since the shock event and the cosmic ray exposure apparently occurred at the same time for all of the four shergottites, Nyquist will go so far as to suggest that perhaps all the shergottites originated in the same place. Other scientists go even further to suggest that the evidence gleaned from the sample 79001 and the other samples indicates that all nine SNC meteorites came from Mars.

"The only conclusive thing would be to go to Mars and find out," said Planetary and Earth Sciences Division Chief Dr. Michael Duke. What is sure is that the detective work and the debates will continue until that day 20 or 30 years hence when either a human or a robot is able to bring a piece of the Red Planet back to Earth where the question can be answered once and for all.

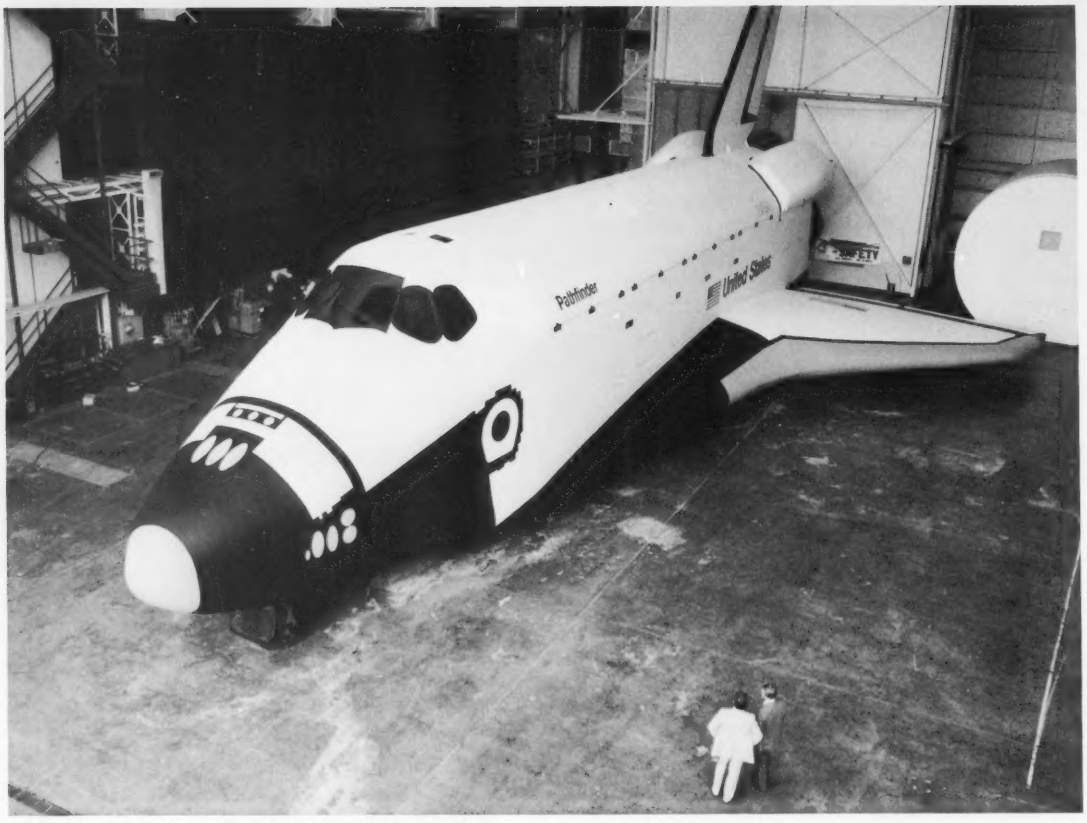
NASA High-Speed Data Management System

NASA-sponsored research is developing a computer system capable of recording data at the rate of 50 million pieces of information per second. Once operational, the system is expected to record *10 trillion* pieces of information and be able to distribute this data to users in real time. This will allow separated specialists to collaborate interactively in a manner never before achieved as current data management systems require weeks, even months, to accomplish this type of data exchange.

The research system, called the NASA High Speed Data Management and Archival System, provides the technology base to handle the dramatic increase in the volume of data being received or expected from current and future satellites and spacecraft.

Although the system's mass memory is still being developed, the remainder of the system is being used on a prototype basis. Dr. James Green, a magnetospheric researcher at NASA's Marshall Space Flight Center, Huntsville, Ala., has organized an advanced computer network linking scientists at Marshall with those at the Goddard Space Flight Center, Greenbelt, Md.; Stanford University in California; Utah State University; the University of Texas at Dallas; the University of Iowa; and the National Laboratory at Los Alamos in New Mexico. This use provides a very valuable checkout of the system and has afforded the magnetospheric research community the opportunity to do things that have previously not been possible.

Space scientists at Marshall, using data from their instrument on the Dynamics Explorer satellite, and Utah State University scientists, through theoretical research, have been independently studying oxygen and hydrogen



Pathfinder to Japan—View of completed full-scale model of America's Space Shuttle to be exhibited at the Great Space Shuttle Exhibition in Tokyo from June 23 through Sept. 15, 1983. The core used to build the model, on loan from NASA, is the Space Shuttle simulator known as the Pathfinder, a pre-Enterprise checkout vehicle constructed at NASA's Marshall Space Flight Center, Huntsville, Ala., in 1977. Pathfinder (orbital vehicle 098) was used as a stand-in for Enterprise, approximating the same size and weight of Enterprise, in extensive ground vibration tests at Marshall and for various facilities fit checks at Marshall and at Kennedy Space Center, Fla.

loss from the Earth's upper atmosphere. The scientists were able to correlate their information through the network and document that not only were oxygen and hydrogen leaving but that nitrogen, too, was escaping.

"The Earth . . . does a remarkable job of maintaining a balance" of its atmosphere by regenerating the gases," said Dr. Joe Doupnik, the network user at Utah State. In praising the system, Doupnik said, "The enormous advantage of this type network is the ability to have 'at our fingertips' whatever information is stored on the many computers available."

The network has allowed the community of interested scientists to work as a closely associated group on almost a daily basis rather than meeting several times a year. "Exchange of ideas and data are vital to doing good science; the network has speeded that process enormously," Doupnik said. In workshops, conducted over the network, each of us can immediately review the other scientists' data, run analysis programs right then to answer a query, and later edit a common draft of a joint paper."

According to Green, "Many scientists have heard about the system and we are hoping to expand the network to accommodate them. We expect to add facilities at Michigan State University and Southwest Research Institute in Texas in the coming months."

The NASA High Speed Data Management and Archival System, sponsored by the Office of Aeronautics and Space Technology under its Data Systems Technology Program and managed by Marshall

Space Flight Center, is being developed by OAO Corporation, RCA Corporation, and Computer Science Corporation (under contract to the Goddard Space Flight Center).

The system consists of three major components: a software system called data base management, a subsidiary software system called packet management; and a large data storage device called the mass memory assembly. The storage device records and stores the data onto 14-inch platters using fiber optics cable to transmit the data to the recorder and a laser to record the data. The two software systems manage requests for data, catalog data records, and direct the flow of data to the various subelements of the total system. Four high-speed minicomputers and a number of microcomputers work together in an intricate interconnection of control loops, data bases, and fiber optic paths.

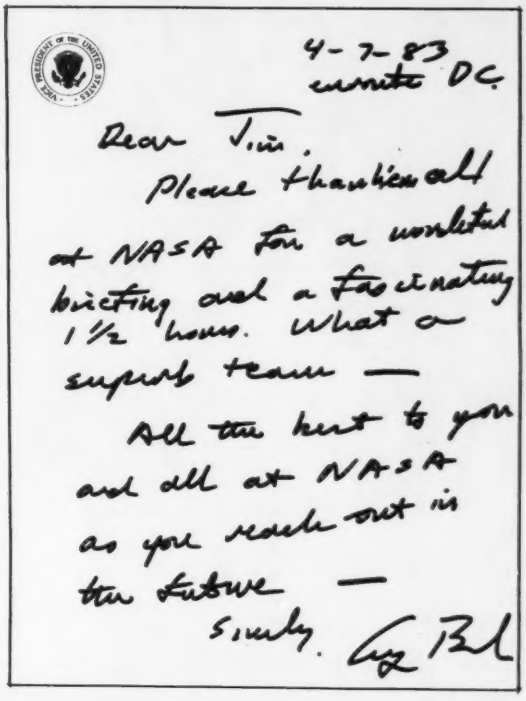
Inspector General Activities

The following report is of a completed recent investigation by NASA's Office of the Inspector General.

NASA Contractors Sentenced and Fined

An intensive, three-year investigation by the NASA Office of the Inspector General and the Federal Bureau of Investigation was culminated on Dec. 20, 1982, with the conviction by a Federal jury in Orlando of three individuals and two firms on charges arising from a scheme to submit fraudulent claims to NASA in connection with the construction of Space Shuttle support facilities at the Kennedy Space Center. The individuals and firms were found guilty of a total of 36 counts of attempting to defraud the Government. On Feb. 1, 1983, the three men and two firms received the following sentences in the U.S. District Court, Middle District of Florida: Phillip W. Akwa, President of Capital Communications Corp., and Arthur L. Boschen, President of New World Construction Co., each received prison sentences of three years on several charges, to be served concurrently. James T. White, Jr., a former employee of New World Construction Company, was sentenced to three years probation. Capital Communications Corp., was ordered to pay a total fine of $90,000, and New World Construction Co., a total fine of $70,000. Combined with a $10,000 fine previously levied upon Mayfair Construction Co., the Government will collect a total of $170,000 in fines.

NASA's Office of the Inspector General urges you to continue your efforts in meeting the challenge of improving NASA programs. Suggestions for eliminating waste and mismanagement are welcome. Identities can be confidential. A 24-hour answering service is available in the Washington, D.C. area on 755-3402 or call (800) 424-9183 (toll free for all other areas). Please send written suggestions to: NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, D.C. 20024.



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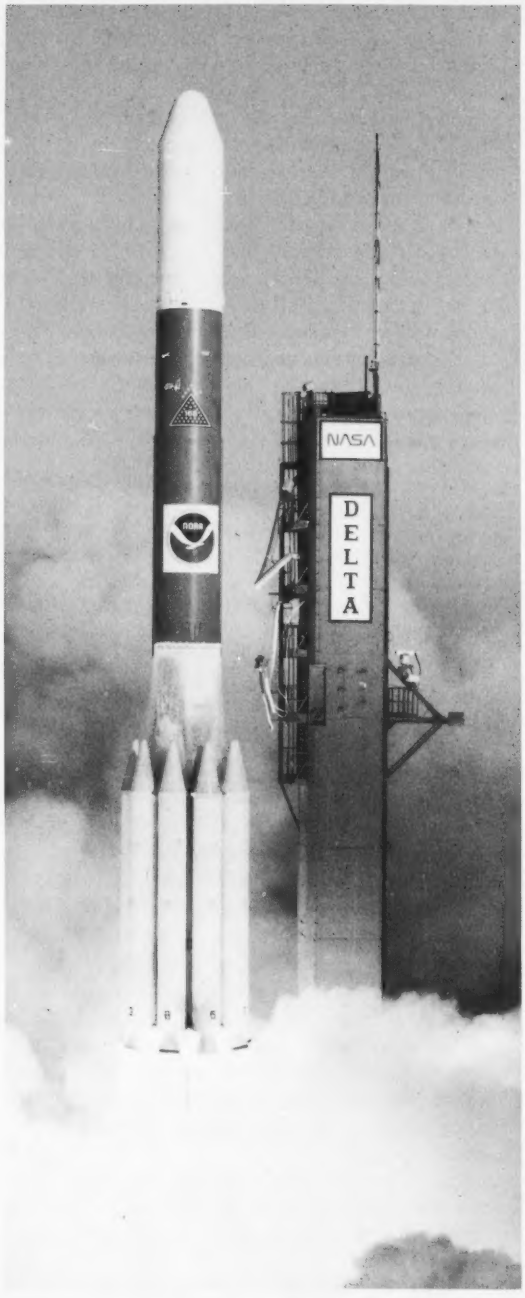
Dear Jim.
Please thank 'em all at NASA for a wonderful briefing and a fascinating 1½ hours. What a superb team —
All the best to you and all at NASA as you reach out in the future —
Sincerely. GB

Presidential Praise—A White House note sent to NASA Administrator James Beggs after a visit by Vice President George Bush to NASA's Johnson Space Center during Shuttle flight 6 in April. The note reads: "Dear Jim, Please thank 'em all at NASA for a wonderful briefing and a fascinating 1½ hours. What a superb team—All the best to you and all at NASA as you reach out in the future—Sincerely, George Bush"

NASA's 25th Anniversary, Oct. 1, 1983
Historical Calendar for June

Date	Event
June 2, 1966	Surveyor 1 lands on Moon
June 2, 1979	Launch of UK-6
June 3, 1965	Launch of Gemini IV
June 3, 1966	Launch of Gemini IX-A
June 3, 1974	Launch of Hawkeye (Explorer 52)
June 5, 1969	Launch of OGO-VI (F)
June 7, 1966	Launch of OGO-III
June 8, 1956	First flight of hypersonic X-15
June 8, 1982	Launch of Westar-V
June 9, 1976	Launch of Marisat-B
June 10, 1973	Launch of Radio Astronomy Explorer-B (Explorer 49)
June 12, 1975	Launch of Nimbus F (6)
June 13, 1972	Launch of Intelsat IV F-5
June 14, 1967	Launch of Mariner V (Venus 67)
June 16, 1977	Launch of GOES-B/NOAA
June 16, 1978	Launch of GOES-C/NOAA
June 19, 1962	Launch of TIROS V
June 19, 1963	Launch of TIROS VII
June 21, 1969	Launch of Explorer XLI (41)
June 21, 1975	Launch of OSO-1 (8)
June 23, 1961	Robert White becomes first man to fly faster than five time the speed of sound in X-15
June 23, 1981	Launch of NOAA-C
June 24, 1966	Launch of Pageos 1
June 26, 1978	Launch of Seasat-A
June 27, 1961	NASA pilot Joe Walker flew X-15 to unofficial world speed record of 4,104 mph
June 27, 1979	Launch of NOAA-6
June 27, 1982	Launch of STS-4
June 28, 1969	Launch of Biosatellite III
June 29, 1979	Launch of COMSTAR D-3
June 30, 1964	Launch of Atlas Centaur 3



Third GOES Launch—Launch of GOES-F, the third in a series of three improved Geostationary Operational Environmental Satellites launched from Pad 17-A Delta launch facility at Cape Canaveral Air Force Station, Fla. on April 28 at 6:25 p.m. EDT. GOES is a National Oceanic and Atmospheric weather satellite.

NASA Sponsors Space Shuttle Technical Conference

NASA's Johnson Space Center, Houston, will host a three-day Space Shuttle Program Technical Conference June 28-30, in which detailed technical papers of archival quality will be presented on the fundamental scientific and engineering data derived from the Space Shuttle development program. Theme of the conference is "The Space Shuttle Program: From Challenge to Achievement"; Associate Administrator for Space Flight, Lt. Gen. James A. Abrahamson, is scheduled to deliver the keynote address on the challenges faced in the design, development, and testing that led to the operational Space Transportation System. Chairman of the conference is Aaron Cohen, Director of Research and Engineering at Johnson.

Presentations for the conference will be held in three concurrent technical sessions; subjects have been selected by co-chairmen from NASA and various contractor teams. Topics to be presented include: Integrated Avionics; Guidance, Navigation, and Control; Aerodynamics; Structures; Life Support, Environmental Control, and Crew Station; Ground Operations; Propulsion and Power; Communications and Tracking; Mechanisms and Mechanical Systems; and Thermal and Contamination Environments and Protection Systems.

Contractor participants in the conference include representatives from Rockwell International; Rocketdyne; Lockheed; Martin Marietta; Hamilton Standard; Vought Corp.; U.S. Space Boosters, Inc.; Thiokol; McDonnell Douglas; and Aerojet.

Proceedings of the conference will be published. The evening of the first day will feature a dinner speaker: Dr. Glynn Lunney, Manager of the Space Transportation System program. A luncheon will be held on the second day and will feature Apollo-Soyuz astronaut Deke Slayton. There will be no charge for attendance at the technical sessions of the conference but there will be a small fee for attendance at the dinner and luncheon. For registration details or further information on the Space Shuttle Program Technical Conference contact Norman Chaffee at (713) 483-3995, (FTS) 525-3995; or Ernest R. Hillje at (713) 483-3405, (FTS) 525-3405, at the Johnson Space Center.

At brief schedule of the sessions scheduled for the Space Shuttle Technical Conference follows. A detailed schedule listing session co-chairmen, titles of presentations and speaker(s) as well as length of individual papers can be obtained from Chaffee or Hillje.

Space Shuttle Program Technical Conference
June 28-30, 1983
NASA Johnson Space Center, Houston, Texas

		Location at Johnson Space Center	
Date/Time	**Building 2 Auditorium**	**Building 30 Auditorium**	**Building 7 Auditorium**
Tuesday June 28 *1:00-4:30 p.m.	Aerodynamics (session 1)	Ground Operations (session 1)	Life Support, Environmental Control and Crew Station
Wednesday June 29 8:30-11:30 a.m.	Integrated Avionics (session 1)	Propulsion and Power (session 1)	Communications and Tracking
Wednesday June 29 1:30-5:00 p.m.	Mechanical Systems (session 1)	Aerodynamics (session 2)	Ground Operations (session 2)
Thursday June 30 8:30-11:30	Thermal and Contamination Environments and Protection Systems	Integrated Avionics (session 2)	Propulsion and Power (session 2)
Thursday June 30 1:00-5:00 p.m.	Structures	Guidance, Navigation and Control	Mechanical Systems (session 2)

* Times are approximate; consult detailed schedule for exact times for each session.

New NASA Publications

The following are new NASA Special Publications available for purchase from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Nimbus 6 Random Access Measurement System Applications Experiments (NASA SP-457), edited by Charles Cote, Ralph Taylor and Eugene Gilbert. Paperbound; 106 pgs.; GPO stock number 033-000-0867-8; $5.50. NASA initiated the Nimbus satellite program in the early 1960s to develop an observatory system capable of meeting the research and development needs of the nation's atmospheric and Earth scientists. Investigators from around the world were invited to conduct experiments from a variety of platforms during the four-year life of the satellite; users included oceanographers, polar investigators, commercial oil drillers, marine scientists, and environmental scientists. The book highlights typical applications experiments carried out during the years 1974-79. These experiments paved the way for expanding satellite location and data collection technology.

Small Transport Aircraft Technology (NASA SP-460), by Louis J. Williams. Paperbound; illustrated; 118 pgs.; $5.00. Results and conclusions of a set of 12 studies by NASA's Small Transport Aircraft Technology team. The study discusses those portions of NASA's overall aeronautics research and technology program which have applicability to commuter aircraft design and suggests areas of technology which might beneficially be initiated or expanded. This book should appeal to a variety of specialists in the field: manufacturers, airlines, universities, consultants, and government agencies.

Space Physiology and Medicine (NASA SP-447), by Dr. Arnauld Nicogossian and Dr. James Parker, Jr. Casebound; illustrated; 336 pgs.; $15.00. Comprehensive overview of current knowledge relating to spaceflight factors such as weightlessness and the impact of these factors on the health and physiology of man in space. Biomedical issues and technical considerations relevant to the application to a program of space medicine and the provision of medical services to space crews are discussed. The volume is divided into **six sections.**

Shuttle Mission Emblems—Challenger on its second flight into space is the featured art for the crew patch for mission 7, with the Remote Manipulator System extended to form the numeral 7. Also representing the flight number are the traditional use of seven stars, visible in the background. Within the Sun's center at bottom right of the insignia is a symbolic representation for the five crew members which includes, for the first time, a woman astronaut, Sally K. Ride. Mission insignia for Space Shuttle Mission 8, scheduled for launch in August, depicts Space Shuttle Challenger hurtling toward its third mission in space. The eight stars that traditionally signify the mission number are visible in the background.

Space Kitchen Fittings—Space Shuttle Orbiter Columbia undergoes fit checks for the new kitchen or galley to be installed for flight nine, the Spacelab mission. The galley is a multi-purpose facility that provides food preparation facilities, meal stowage accessories, food trays and oven inserts and enough trash stowage for seven days. Food is individually packaged in rehydratable, thermo-stabilized, or ready-to-eat forms. The oven will heat a meal for as many as seven persons in approximately 90 minutes, and has a heating range of 145 to 185 degrees Fahrenheit in operational flight.

Section I summarizes the history of manned spaceflight in the United States and the Soviet Union, with emphasis on the emergence of significant biomedical findings. **Section II** discusses characteristics of near-Earth space environment, the lunar environment, and the surface and atmospheric environments of other planets of the solar system, from the point of view of the life sciences. **Section III** reviews space vehicles that have been developed for both the American and Soviet manned spaceflight programs, and discusses requirements for life support in the spacecraft cabin and during extravehicular activity. **Section IV** discusses the physiological responses to spaceflight and ground based simulations in terms of specific physiological systems and functions. **Section V** provides an overview of issues and procedures relating to the selection, training and long-term health maintenance of astronauts and other mission personnel. **Section VI** identifies specific medical problems, such as toxic hazards and radiation exposure, encountered in the planning and execution of medical programs in support of manned spaceflight.

What's New in NASA Television and Radio Programming

Programs released in May (and June for television):

Television:
Aeronautics and Space Report—Two part series (4½ minutes)
NASA's ET (May)
Pioneer 10 . . . Beyond the Solar System (May)
Aeronautics and Space Report (14½ minutes)
Space Shuttle: Flight 7 (June)

Radio:
Viking and the Search for Life on Mars (14½-minute monthly report; featuring Dr. Harold Klein, Ames Research Center)
The Galileo Spacecraft (4½-minute weekly report; featuring Dr. Torrence Johnson, Jet Propulsion Laboratory)
Plans for Comet Halley (4½-minute weekly report; featuring Dr. Donald Yeomans, Jet Propulsion Laboratory)
Space Technology Used in Art (4½-minute weekly report; featuring David Glackin, Jet Propulsion Laboratory)
Arecibo Telescope Explores the Universe (4½-minute weekly report; featuring Dr. Yervant Terzian, Cornell University and Dr. Don Campbell, Arecibo Observatory, Puerto Rico)
Space Notes (1 minute each):
Lunar Rocks Found on Earth
AXAF . . . A Look into the X-ray Sky
Pioneer Leaves the Solar System
Dramatic New Discoveries with IRAS
Deep Into Space with Space Telescope
Space Technology Used on Sunken Ships
Advanced Propeller Research
Laboratory in Space
Rocket Experiments in Peru
Space Shuttle Seven

Copies of television tapes are sent simultaneously to all NASA Visitor Information Centers and Public Affairs Offices, and to 650 television stations nationwide as well as to 425 cable television systems via the satellite SATCOM III. Five hundred television stations receive material formatted as a 4½-minute program; the remaining 150 stations receive a 90-second "spot"—a condensed version of the 4½-minute presentation.

NASA's radio programs are sent to over 2,000 radio stations across the nation; in addition, translations of the recordings are made by Voice of America and Radio Free Europe and these tapes are then released to the appropriate audiences overseas. Released each month are one report of 14½ minutes and four 4½ minute weekly stories (one story in the set is featured for one week of the month). Ten 1-minute space notes are released quarterly.

Contractor News

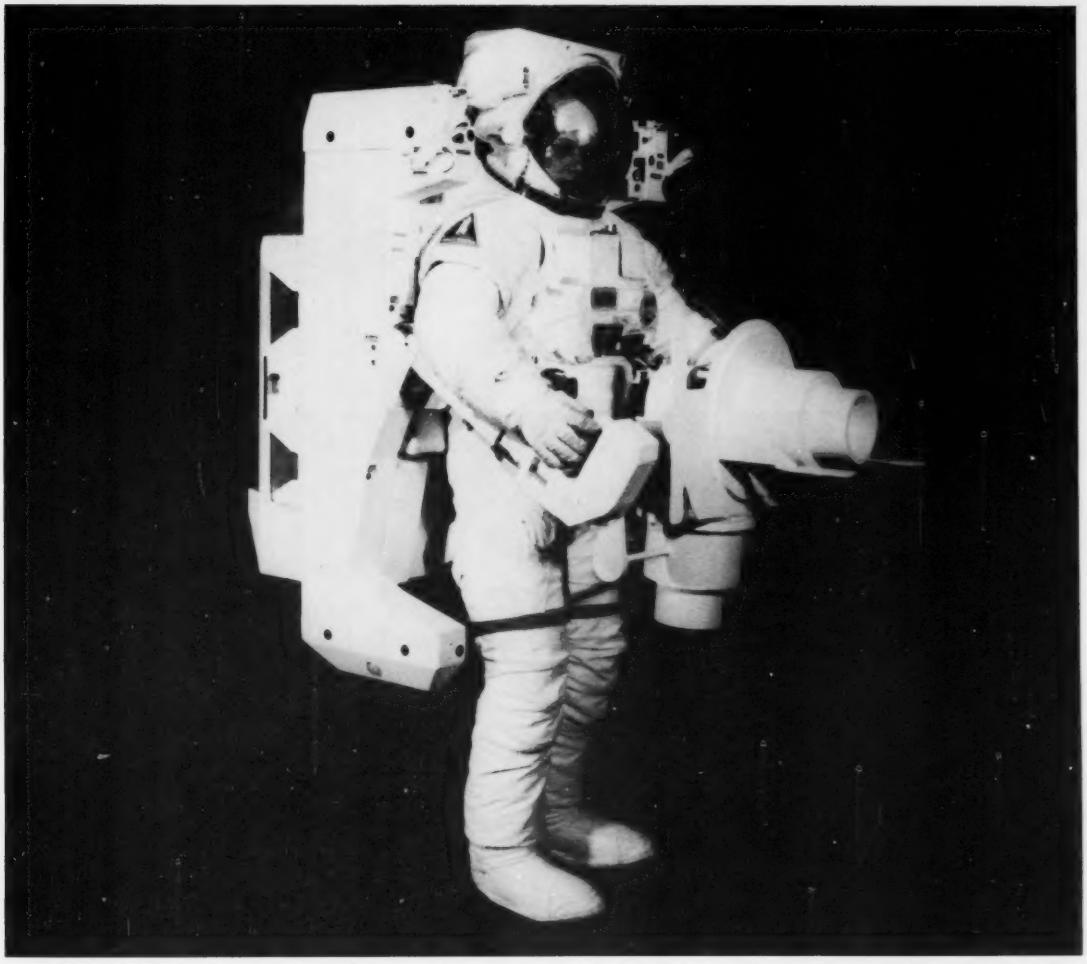
NASA's Lewis Research Center, Cleveland, has awarded the first of three parallel contracts to provide the research and technology for an advanced propulsion system for an orbital transfer vehicle to be used with the Space Transportation System. **Aerojet Liquid Rocket Co.,** Sacramento, Calif., was awarded the first contract for approximately $3.5 million. The award calls for exploration of advanced engine concepts and associated propulsion system technologies for an orbital transfer vehicle that would be used to transfer loads—both personnel and cargo—between low Earth orbit and geosynchronous orbit and beyond. The program stresses innovative concepts and technologies for a reusable engine for a vehicle which could be based and serviced in space. This cost-plus-fixed-fee contract, effective April 11, 1983, covers a five-year period. Work is to be performed at the contractor's plant in Sacramento.

NASA's Kennedy Space Center, Fla., has awarded the following contracts:

Behe and Umholtz Electrical Contractors, Orlando, Fla., a $1.3 million contract to modify areas of the Launch Control Center. The term of the fixed-price contract began March 16, 1983 and extends to Oct. 13, 1983. Under terms of the contract, Firing Room 4 will be modified to prepare it for the installation of launch related equipment to support Space Shuttle launches. The contract also calls for the necessary facilities for the installation of additional uninterruptable power supplies. These systems supply power to launch critical equipment. Air handling units also will be provided to cool the power system located on the first floor of the Launch Control Center.

IBM Corp., Federal Systems Div., Oswego, N.Y., a $1.5 million contract extension for the manufacture and delivery of one general purpose computer system in support of the Air Force Orbiter Functional Simulator at Vandenberg Air Force Base, Calif., by Jan. 1985. This fixed-price contract totals $5.3 million. The Orbiter Functional Simulator is the U.S. Air Force's version of NASA's Cargo Integration Test Equipment facility which verifies the compatibility of payloads with the Shuttle orbiter.

Harris Corp., Government Systems Div., Melbourne, Fla., a $1.2 million contract extension in support of Space Shuttle cargo operations. Under terms of the fixed-price contract, Harris is to manufacture and deliver three separate pieces of equipment in support of the Orbiter Functional Simulator at Vandenberg Air Force Base, Calif. The equipment is to be delivered to



Future Space Mobile—Astronaut Bruce McCandless, mission specialist for Space Shuttle Flight 11, scheduled for launch in early 1984, demonstrates a preview of future in-space mobility, attired in an extravehicular mobility unit with a back-pack type apparatus called the manned maneuvering unit (MMU). The MMU represents a concept that will enable astronauts on an EVA to become independent from the Space Shuttle for a period of time to perform certain tasks. The MMU will see its first operational use on Shuttle Flight 13 when astronauts will use the apparatus to reach the Solar Maximum Satellite to perform the first Space Shuttle on-orbit repair.

Vandenberg by Aug. 1, 1984. Vandenberg will become the second launch and landing facility for the Space Shuttle when it becomes fully operational in the mid 1980s. All polar oribt payloads will be launched from that site.

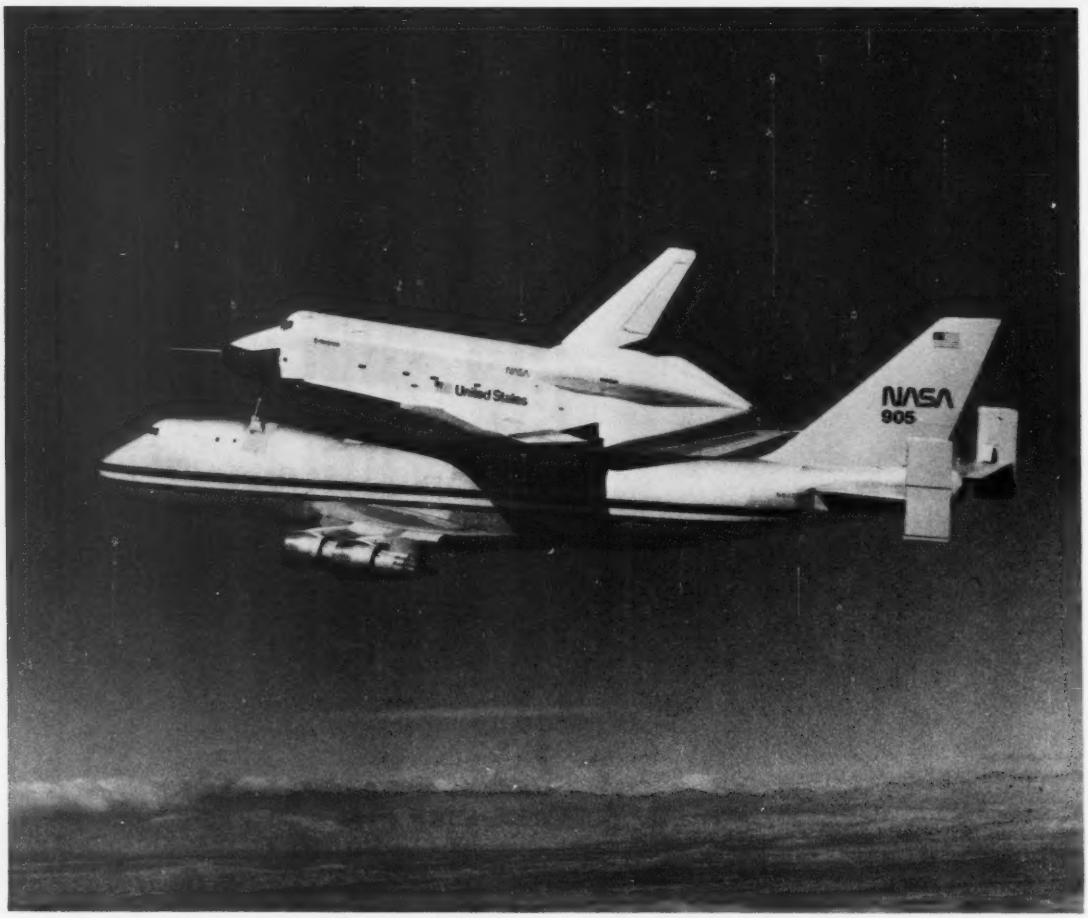
In other contractor news, NASA has signed a $393.9 million supplemental agreement with **Morton Thiokol, Inc.,** Wasatch Div., Brigham City, Utah, to produce solid rocket motors for future Space Shuttle flights. This agreement, which runs through Dec. 1986, covers the production and delivery of solid rocket motors for Space Shuttle flights 7 through 15, the refurbishment of motors flown on flights 1 through 10, and reusable metal parts to support the required deliveries and future requirements.

NASA has announced that the Space Shuttle Solid Rocket Booster refurbishment facility operation will remain at or near Kennedy Space Center, Fla. The agency recently examined the possible merit of relocating the facility from Florida to NASA's Marshall Space Flight Center in Huntsville, Ala. The review was undertaken as part of the overall plan for increasing Shuttle flight rate to 24 missions per year. The study showed no sound basis for such a location change.

Space Shuttle Launches for 1983

Orbiter	Launch Date	Launch Number	Launch Site	Payload
*Challenger (OV-099)	April 4	6	KSC	TDRS-A
Challenger (OV-099)	June 18	7	KSC	OSTA 2; SPAS-01 Telesat-F; Palapa B-1
Challenger (OV-099)	August	8	KSC	INSAT 1-B
Columbia (OV-102)	September 30	9	KSC	Spacelab 1
Challenger (OV-099)	December 14	10	KSC	DOD 84-1

* Successful launch



Enterprise to Paris—Keystone of the United States aerospace exhibit at the Paris Air Show, May 26 through June 5, 1983, will be NASA's Space Shuttle Orbiter Enterprise. Flown aboard the 747 Shuttle Carrier Aircraft, the Enterprise also is scheduled to be displayed at Bonn/Cologne, Federal Republic of Germany; London, England; and Ottawa, Canada. The Enterprise was used as a test vehicle in 1977 for a series of low altitude approach and landing flights at Edwards Air Force Base, Calif., and for launch facility checks at Kennedy Space Center, Fla.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employers	Title	Patent No.	Installation
Curtis E. Tucker and Harold P. Holway, Caltech/JPL	Mobile sampler for use in acquiring samples of terrestrial atmospheric gases	4,377,949	NRO/JPL
Leroy H. Berge, William A. Oran, and John M. Theiss, NASA/MSFC	Gas levitator having fixed levitation node for containerless processing	4,378,209	MSFC
Cyril Feldstein, Thomas W. Andrews, Mark A. Cole, and Donald W. Crawford, Caltech/JPL	System and method for moving a probe to follow movements of tissue	4,378,813	NRO/JPL
Archibald L. Fripp, James B. Robertson, and Roger A. Breckenridge, LaRC	Pyroelectric detector arrays	4,379,970	LaRC
Lai-Wo Fung, National Academy of Science, Washington, D.C.	Massively parallel processor computer	4,380,046	GSFC
Henry D. Obler, NASA/GSFC	Variable speed drive	4,381,174	GSFC
David A. Stewart, Howard E. Goldstein, and Daniel B. Leiser. Stanford University, Stanford, Calif.	High temperature glass thermal control structure and coating	4,381,333	ARC

Expendable Launches for 1983

Name	Launch Date	Vehicle	Range	Mission Remarks
*IRAS	January 25	Delta	WSMC	Infrared astronomy. NASA scientific.
*NOAA-E	March 28	Atlas-F	WSMC	NOAA weather and SARSAT. Reimbursable.
*RCA-F	April 11	Delta	ESMC	RCA communications. Reimbursable.
*GOES-F	April 28	Delta	ESMC	NOAA weather. Reimbursable.
*Intelsat V-F	May 19	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
EXOSAT	May 26	Delta	WSMC	European Space Agency. Reimbursable.
Galaxy-A	June 16	Delta	ESMC	Hughes Communications, Inc. Reimbursable.
HILAT	June 28	Scout	WSMC	Air Force research and development. Reimbursable.
Telstar 3-A	July 28	Delta	ESMC	AT & T communications. Reimbursable.
RCA-G	August 25	Delta	ESMC	RCA communications. Reimbursable.
Galaxy B	September 22	Delta	ESMC	Hughes Communications, Inc. Reimbursable.
NAVY-21	4th quarter	Scout	WSMC	DOD transit. Reimbursable. Call up.
San Marco D/L	November	Scout	SMR	International cooperative/Italy.
AF-1	December	Scout	WFC	Air Force development program. Reimbursable.

* Successful launch

Note: At reader request, following is a brief explanation of terms used in the Launch Schedules: WSMC—Western Space and Missile Center, Vandenberg Air Force Base, Calif.; ESMC—Eastern Space and Missile Center, Cape Canaveral Air Force Station, Fla.; SMR—San Marco Range, off the east coast of Kenya, Africa; WFC—Wallops Flight Center, Wallops Island, Va.; KSC—Kennedy Space Center, Fla. *Reimbursable* expendable launches means that NASA is compensated or repaid for launch expenses incurred by the company or agency whose payload is launched. *Call up* indicates that the launch vehicle and spacecraft are in flight status and have been placed on standby, awaiting final preparations for launch based on the customer request for a launch time and date within a period of time not to exceed 120 days.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans — and at a tiny percentage of the tax dollar. Here is an example:

Implantable Drug Dispenser

A device has been developed that can administer round-the-clock programmed dosages of medication for humans or animals that require constant, controlled rates of liquids or drugs. This implantable dispenser, developed by Earl R. Collins, Jr., of Caltech for NASA's Jet Propulsion Laboratory, Pasadena, Calif.,* can inject directly into the bloodstream controlled quantities of liquids and drugs such as insulin, saline solution, sugar solution, and blood plasma.

Dosage is controlled by differential vapor pressure on opposite sides of the diaphragm which, in turn, is controlled by the device's integrated heating system. This heating system's regulation of the vapor pressures forces the liquid or drug into the bloodstream. The drug, in liquid solution, is held in a central chamber that connects to a tube leading to an artery.

A 30-day drug supply can be administered at a rate of one cubic centimeter per day. Microprocessor sensors built into the device monitor the body's temperature and indirectly control the rate and amount of fluid dispensed.

This implantable device is smaller than other previously developed dispensers which used liquids as the pressure media which, in turn, required a large volume to dispense a comparable amount of medication.

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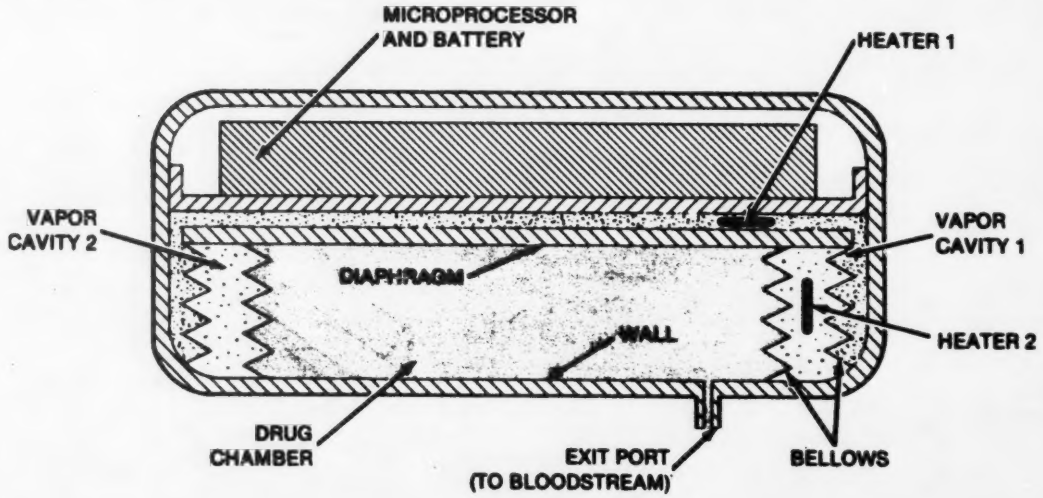
* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office, Jet Propulsion Laboratory, Pasadena, Calif. 91103. In your inquiries, refer to NPO 15160.

NASA
National Aeronautics and Space Administration